Use Only

1995 Abstract Form
Scientific Presentations
' OF MAGNETIC RESONANCE
RD SCIENTIFIC MEETING
EAN SOCIETY FOR MAGNETIC
NCE IN MEDICINE AND BIOLOGY
'ELFTH ANNUAL MEETING
e Acropolis, NICE, FRANCE
August 19-25, 1995

)ral Presentation but
o present as a poster
'oster but willing to make
sentation
)nly
o required (available only
)ral Presentations)

\TEGORIES
S SHOULD FILL IN A
:AL CATEGORY

:GORY [4]
-Animal Studies
-Human White Matter
-Human Other
)nal Neuro—Clinical
Neck, Spine and Other
ascular
Dynamics and Flow
ascular—Clinical
Chest
ntestinal
ırinary
Cartilage, Bone and Marrow
ır Imaging
ntional MRI

)SCOPY
:GORY [ ]
)scopic Imaging Techniques
uclear Spectroscopy
)scopic Quantitation
ı Brain—White Matter & Neuro
erative
ı Brain—Stroke & Seizure
ı Brain—Other
Brain
vascular
ıinal
loskeletal
s—Methods and Animal Models
s—Clinical
(including body fluids)

)OLOGY
:GORY [ ]
raphy
)uantification
on
on
onal Neuro—Methodology and Analysis
onal Neuro—Models and Mechanisms
copy, Non-proton Imaging and ESR
nts and Hardware
ils
lses
Imaging
Localization/Imaging
ı and Artifacts
Sequences/Techniques
tative Imaging
Processing
splay/Rendering
ıst Mechanisms/MTC
agnetic Contrast Agents
Contrast Agents
Bioeffects
entional MRI

CT DEADLINE:
ıo later than April 11, 1995.
hts to accepted abstracts become the
f the SMR. No proprietary information
hheld by authors.

):
iety of Magnetic Resonance
rd Scientific Meeting
8 Milvia Street, Suite 201
keley, CA 94704, USA

nailing abstracts from outside the
ld allow six weeks for mailing or
racts by express.

e the name and complete
dress of the first author.
ROBERT SAVOY
The Rowland Institute
100 EDWIN LAND BLVD
CAMBRIDGE, MA
02142
USA
617 497-4647
617 497-4627

f SMR? [ ] Yes [X] No

Use Only:
M #________

Pushing the Temporal Resolution of fMRI: Studies of Very Brief Visual Stimuli, Onset Variability and Asynchrony, and Stimulus-Correlated Changes in Noise

R.L. SAVOY†*, P.A. BANDETTINI*, K.M. O'CRAVEN†*, K.K. KWONG*, T.L. DAVIS*, J.R. BAKER*, R.M.WEISSKOFF*, & B.R.ROSEN*

†*Rowland Institute for Science, 100 Edwin Land Boulevard, Cambridge, MA 02142*

**MGH NMR Center, Massachusetts General Hospital, Charlestown, MA 02129*

INTRODUCTION We have been developing methods to enhance the effective temporal resolution of functional magnetic resonance imaging (fMRI). One goal has been to achieve averaging of the data across many runs on a given individual while minimizing loss of temporal or spatial accuracy. Another goal was to examine the temporal variability of the latency of the hemodynamic response to neural activation. Collecting multiple runs in a single session allowed variability analysis of the response curves.

METHODS Visual stimuli were hardware-synchronized with the scanner for each trial. A bitebar (used by four of the five subjects) was installed to help minimize head movements. Preliminary gradient echo data collected with stimuli of 100 msec duration and TR=100 clearly indicated a signal when averaged over 10 trials. We then conducted a systematic series of experiments with TR=400 (or 500), TE=50, Flip Angle=53° and stimulus durations that were both shorter and longer than 100msec. The imaging system is a 1.5 Tesla GE Signa modified by Advanced NMR, Inc. We imaged a single 7mm oblique slice through the calcarine fissure of each individual, using a surface coil.

RESULTS In all studies subjects fixated a small dot in the center of the screen throughout the experiment. In the studies of brief stimuli a large, circular black-and-white checkerboard pattern was presented for 1000, 100, or 34 msec starting at 20 seconds during an 80 second run. The question was: Would a clear fMRI signal modulation be elicited by these very brief stimuli?

Figures 1 shows the MR signal for a single subject as a function of time, in a region of interest selected on the basis of the area most active for the 1000 msec visual stimulus. The data in Figure 1 is based on the average of 10 runs at each of the stimulus durations indicated (1000, 100, 34 msec). Only the data in the temporal region near stimulus presentation is shown. There is a clear response to each of the averaged stimuli.

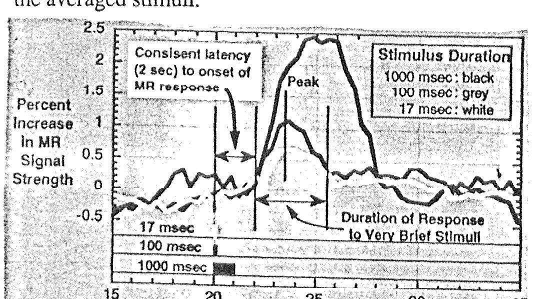

Figure 1: Detail Near Stimulus Onset

In studies of temporal onset variability and asynchrony, visual stimuli were presented to each hemifield for 10 seconds ON, 15 seconds OFF, every 25 seconds for 10 repetitions over 250 seconds. Onset of visual stimuli in each hemifield was offset by 500 msec relative to the other hemifield. Multiple runs of this stimulus were collected for each subject. Two questions were asked.

First: Given the large number of individual epochs generated (e.g., 100 = 10 runs x 10 ON epochs per run), how much temporal variability would there be in the onset of the fMRI signal? The response over many epochs was averaged and the resulting time course was used to compute correlation coefficients with the original data. The peak of correlation was used to estimate the onset time for each epoch. Preliminary studies indicate that the resulting standard deviation of onset time was less than 500 msec.

Second: Given the preceding measure of absolute temporal certainty for the onset of a signal, would relative differences across the hemispheres be detected with similar resolution? Figure 2 indicates that such differences (500 msec) could be detected.

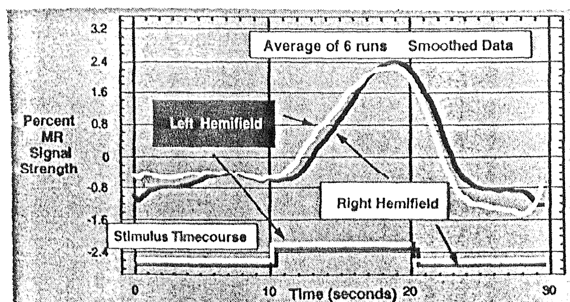

Figure 2: 500 msec Hemifield Onset Asynchrony

In both of the preceding studies we noted unanticipated changes in the standard deviation of the raw fMRI signal that was time-locked with the stimulus. In 10 runs of the brief (1000 msec) stimulus, several subjects showed a decrease in fMRI variability at stimulus onset and increase at stimulus offset. Figure 3 illustrates this for one subject (the same as in Figure 1) by showing the 10 individual time courses. This finding has been seen with several, though not all, other subjects.

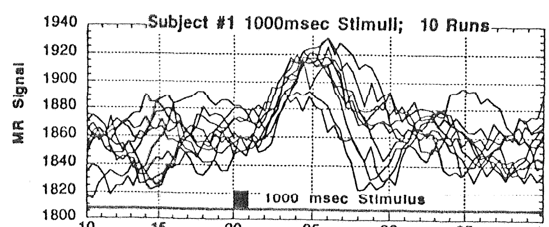

Figure 3

CONCLUSIONS Although the temporal resolution of fMRI is inherently limited by the slowness of the hemodynamic response, we have demonstrated that (1) this response can be elicited by a stimulus of much shorter duration than the response itself; (2) the average latency of the response is highly consistent; (3) 500 msec offsets in stimuli presented to (widely) different parts of the brain can be discriminated; and (4) there are intriguing stimulus-correlated changes in fMRI signal variability. All of these facts are significant for the optimal design of perceptual and cognitive tasks in fMRI, as well as being important for the modelling of the biophysics underlying the fMRI signal response time course.